

<sup>b</sup> Applied the NO<sub>x</sub> humidity correction factor for diesel engines based on 40 CFR Chapter I Section 86.1342-90 (2003).

For CO emission rates, there is not a clear pattern regarding the change when comparing the two fuels for the different vehicle groups. The greatest percentage decrease was for the smaller trucks with the older engines. The average decrease for the newer vehicles was approximately the same for both the single rear-axle and tandems. The average change in CO emission rate for the older tandems was insignificant.

For PM, there were insignificant to modest reductions in average emissions rates, with the largest decreases occurring for the single rear axle vehicles.

Table ES-1 summarizes the change in average fuel consumption and emission rates when averaged over all four vehicle groups. The average changes in fuel consumption and CO<sub>2</sub> emissions rates imply a slight increase in both. A slight increase is expected, because of differences in the fuel properties, as previously discussed.

The average decrease in NO emissions rate is 10 percent. Data reported elsewhere imply, on average, that NO<sub>x</sub> emissions rate increase by approximately 2 percent for B20 biodiesel versus petroleum diesel.

There are at least three possible reasons for the observed decrease in NO emissions rate and why this appears to be different from previously reported comparisons. One is that the distribution of time in different operating modes is different for the real world duty cycles versus the laboratory dynamometer cycles. The data obtained in this study imply that the ratio of NO emissions rate on B20 biodiesel to petroleum diesel depend on the operating mode. For example, low cruise tends to produce higher NO emissions rate on B20 biodiesel than does the high acceleration mode, whereas high acceleration, on average, had a lower NO emissions rate for B20 biodiesel versus petroleum diesel for all four vehicle groups. Thus, driving cycles that have more emphasis on modal activity similar to low cruise might imply higher NO on B20 biodiesel, whereas those with less emphasis on this type of activity might imply lower NO emissions rate. The duty cycles of this work were measured in the field and thus are representative of real world in-use activity patterns.

Measurements were made of NO but not of total NO<sub>x</sub>. It could be the case that the ratio of NO<sub>2</sub> to NO varies either by operating mode, for different fuels, or for combinations of both. The PEMS used in this project does not have a capability to measure NO<sub>2</sub> or total NO<sub>x</sub>. However, it could be possible to obtain supplemental equipment to make measurements of NO and total NO<sub>x</sub> for comparison with the PEMS measurements. Data in the literature imply that engine-out emissions rate of NO<sub>x</sub> typically are comprised of only 5 to 8 percent, on average, of NO<sub>2</sub>, with the majority of the NO<sub>x</sub> in the form of NO. However, there are little data available at this time to characterize the ratio of NO<sub>2</sub> to NO<sub>x</sub> as a function of operating mode.

A third consideration is that others have reported that NO<sub>x</sub> emissions rate tend to decrease for B20 biodiesel versus petroleum diesel if the biodiesel conforms to the applicable ASTM standard. However, if the glycerin content of biodiesel exceeds the standard, apparently NO<sub>x</sub> emissions rate may increase. The observation in this study of a reduction in average NO emission rates could imply that the biodiesel fuel used here has low glycerin content; otherwise, an increase in NO emission rate would be expected.